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A Fast Track to Innovation

Experimentation:
What Can It Provide The Operational Level Commander?

By

Craig S. Olson

Lieutenant Colonel, U.S. Air Force

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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James R. Fitzsimonds, Captain, USN
Edwin T. Layton Chair of Intelligence
U.S. Naval War College

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A FAST TRACK TO INNOVATION

Experimentation: What Can It Provide The Operational Level Commander?

The only thing harder than getting a new idea into the military mind is getting an old one out.

B.H. Liddell Hart

Assume for a moment that prior to the recent NATO bombing campaign in Serbia, an experiment had been conducted to investigate alternative technologies and/or force structures to defeat the anticipated Serbian military threat in Kosovo. The Army, for example, might have assembled a rapidly deployable "strike force" composed a combination of helicopter, rocket artillery, airborne assault, and armored maneuver groups with combined firepower, speed, and agility unlike any in the existing 10 divisions, which are either light infantry or heavy mechanized.[1] This radical departure from the traditional Army combat unit may not have been instantly received nor politically supportable as a valid approach to the conflict. However, if the experimental results were compelling enough, it may have at least planted the seeds for a revolutionary rethinking of appropriate Army warfighting concepts for 21st century warfare.

Service and joint experimentation programs have recently emerged as means to expose warfighters to new technologies and concepts in operational environments. The notional example above demonstrates just one of many ways in which experimentation can accelerate the innovation process by increasing the potential for rapid fielding of new technologies, as well as operational, organizational, and doctrinal concepts. The timely question, however, is whether the experimentation process is indeed evolving in a manner that will allow it to provide both *evolutionary* and *revolutionary* improvements in warfighting capability for the operational level commanders of tomorrow.[2] They need and deserve both as they face the dynamic threat environment of the 21st century.

Beginning with a proposed framework for the proper role of experimentation in the innovation process, followed by an examination of ongoing service programs, as well as U.S. Atlantic Command's (USACOM) proposed Joint Experimentation program, this paper will

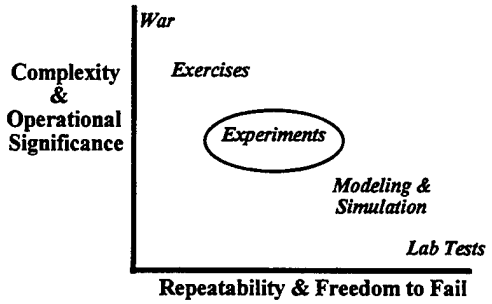
analyze whether these efforts are fulfilling their promise. Finally, it will recommend ways to improve the contribution of experimentation towards increasing the warfighting capability of operational level commanders.[3]

Experimentation—an Innovation Gap-Filler

The 21st century is essentially upon us with a global environment likely to be characterized by diverse symmetric and asymmetric threats and rapid technology change.[4] The Congress, the Secretary of Defense, the Chairman of the Joint Chiefs of Staff (CJCS), and the service chiefs have each declared the importance of experimentation as a means of fostering innovation and rapidly fielding new concepts and capabilities to maintain the dominance of the U.S. military in this challenging environment. Before analyzing today's experimentation efforts, however, it is important to define the role of experimentation in the overall context of innovation.

For the purposes of this analysis, "innovation" is defined as the process of transitioning new technologies, as well as operational, organizational, and doctrinal concepts, from idea to warfighting reality.[5] There are several tools available to evaluate the potential of an innovative concept (Figure 1).

Figure 1
Spectrum of Innovation Tools[6]



"Experimentation," as presently being conducted by the Department of Defense (DoD), can be considered to lie on a spectrum of such tools, contrary to the traditional academic sense of the term.[7] The ultimate test of any innovation is war, but the price of failure makes it a risky place to evaluate new concepts. Exercises offer only limited opportunities for innovation since their primary purpose is to maintain the readiness of current forces, thus restricting the freedom to fail. Laboratory tests and modeling/simulation tools, on the other hand, offer a greater freedom to explore innovative technologies and concepts. However, these tools cannot fully validate innovative concepts because they do not employ actual warfighters and equipment in operational scenarios. Consequently, until recently, this left a substantial gap in the spectrum of tools—a means which combined operational significance with the freedom to fail—where both evolutionary and revolutionary concepts might be revealed.[8]

The concept of experimentation is not new, as a brief look at history illustrates. The U.S. Army organized a dedicated Experimental Mechanized Force in November of 1930. Its purpose was to develop the proper equipment and doctrine for mechanized units, and it consisted of troops from all branches of the Army.[9] Furthermore, formal direction was given to "forget branch rivalries and traditions" in order to make progress towards mechanization. The experiment was considered a success in demonstrating the potential effectiveness of the combined arms concept. However, it was not until 1940 that an operational armored division was finally formed. The delay can be attributed to a number of causes, not the least of which was the premature disbanding of the Experimental Force and the failure of senior Army leadership to fully buy into the concept.[10]

The U.S. Navy was much more successful in the interwar years with its innovative approach to carrier aviation. By connecting realistic annual fleet exercises with the education of top-notch officers and wargaming at the Naval War College, the Navy came as close as any previous military organization to *institutionalizing* innovation, thus preparing them to fight well in the Pacific Theater of World War II.[11]

What is particularly interesting is that neither of these innovations involved a revolutionary technology.[12] In the case of carrier aviation, for example, the source of innovation was primarily new operational and organizational concepts which were developed from exploring such issues as the types of aircraft which should have priority in a carrier air group and the number of aircraft which could be massed for strikes.[13]

Benchmark Considerations for Experimentation

With the successes and failures of historical experimentation as a backdrop, and DoD goals at the forefront, the following criteria can serve as benchmarks to consider while analyzing the experimentation efforts of today.[14]

- Relevance: Are experiments operationally significant with respect to the needs of warfighting commanders?[15]

- Responsiveness: Are experiments conducted often enough to allow adjustments based on failure and to foster rapid fielding through incremental improvements?

- Freedom to Fail: Do planners and participants in experiments have a freedom to fail? This is absolutely essential to allow the building of meaningful scenarios which explore the envelope of "the possible." Freedom to fail is closely tied to responsiveness since failure is inherently less desirable and practical as the frequency of experiments decreases.

- Flexibility: Do experiments address the full conflict spectrum, as appropriate, including both symmetric and asymmetric vulnerabilities?

Furthermore, are both evolutionary and revolutionary approaches considered—whether technologically or conceptually based?

- Buy-in Potential: Is the experimentation process "connected" with operators/innovators at the tactical, operational, and strategic levels, such that the potential for rapid acceptance by the warfighting community is maximized? This includes an appropriate interface between the services which should maximize interoperability and minimize redundancy.[16]

Experimentation Today—An Analysis

To capture the DoD intent with respect to experimentation, the individual services initiated experimentation programs independent of each other at different points throughout the 1990s. Navy, Marine Corps, Air Force, and Army programs will now be described, then analyzed, in light of the benchmark criteria.[17]

Navy Fleet Battle Experiments

Since March 1997, the U.S. Navy has conducted Fleet Battle Experiments (FBEs) at roughly six month intervals—completing five to date. They are the responsibility of the Maritime Battle Center (MBC)—a branch of the Navy Warfare Development Command (NWDC), which is co-located with the Naval War College in Newport, RI. Each FBE is executed by one of the Numbered Fleets, and they are aligned with actual fleet exercises when possible.[18]

The focus of FBEs has been on rapidly maturing new operational concepts and technologies in response to Numbered Fleet Commander and Navy Component Commander problems. Among these are naval fires, theater air defense, command and control from the sea, operational maneuver from the sea (OMFTS), maritime superiority in the littoral, and logistics/sustainment of naval forces.[19] Consistent with Navy core competencies, experiments primarily capitalize on technology to increase effectiveness at the high end of the conflict

spectrum.[20] One indication of this is the concept of network-centric warfare, which weaves a common thread through many of the operational concepts being explored by FBEs.[21]

Marine Corps Sea Dragon

Closely aligned with the Navy FBE process is the Marine Corps Sea Dragon experimentation program. This process was initiated in 1996 with four specific aims: 1) achieving enhanced naval and joint expeditionary capabilities, 2) creating rapid military innovation while meeting current commitments, 3) serving as a process for change, and 4) enabling the warfighter through science and technology.[22] Sea Dragon is a five-year plan administered by the Marine Corps Warfighting Laboratory (MCWL) consisting of discrete phases, each with different objectives. Advanced Warfighting Experiments (AWEs) culminate each phase and occur approximately every two years. The experiments are executed by the MCWL's Special Purpose Marine Air-Ground Task Force (Experimental), or SPMAGTF(X), which is augmented by operational elements when deployed. Additionally, each Sea Dragon AWE is conducted jointly with a Navy FBE.

The first AWE, "Hunter Warrior," was completed in March 1997. Its objective was to explore whether a modest-sized forward afloat expeditionary force (2000 soldiers) could effectively engage a typical brigade-sized mechanized unit (5000 soldiers) through asymmetric application of new technologies and a revolutionary restructuring of the command, aviation combat, ground combat, and combat service support elements of the SPMAGTF(X).[23] The second AWE, "Urban Warrior," was completed in March 1999 and focused on the development of new technologies, operational concepts, and tactics, techniques, and procedures (TTPs) for the urban battlespaces of the 21st century. The final phase of Sea Dragon will culminate with the "Capable Warrior" AWE in 2001, which will

concentrate on the TTPs necessary to make the Marine Corps' conceptual doctrine for the future, OMFTS, a reality.[24]

Air Force Expeditionary Force Experiments

The U.S. Air Force began its experimentation program in the summer of 1998 with the first of a series of annual Expeditionary Force Experiments (EFXs). As directed by the Air Force Chief of Staff, EFXs are designed to demonstrate emerging Air Force capabilities to deploy and employ an Aerospace Expeditionary Force to decisively halt an enemy invasion anywhere in the world.[25] The Aerospace Command and Control & Intelligence, Surveillance, and Reconnaissance Center (AC2ISRC) is the implementing agency, while the experiments themselves are conducted by the Air Force Experimentation Office (AFEO). Like the Navy and Marine Corps programs, EFXs also employ actual operators from the field in the planning and conduct of experiments. Moreover, beginning in 1999, the AFEO is making a concerted effort to increase the jointness of the effort, hence its designation as "JEFX '99."[26] The joint nature is further extended by the feeding of key observations and recommendations into the Joint Universal Lessons Learned System (JULLS), an aspect unique to the Air Force experimentation effort.

Army Force XXI

The U.S. Army Force XXI Joint Venture experimentation program consists of two separate efforts: the Joint Contingency Force (JCF) AWE, and the Division Capstone Exercise (DCX). The objective of JCF is to improve the warfighting capability of light contingency forces through digitization, enhanced communications, and joint interoperability.[27] In addition, like the USMC's Urban Warrior, it is also focused on achieving improved capability in urban/restrictive terrain. The JCF light force, also known as

a "Strike Force," is designed to have more firepower than the light divisions of today, yet be far more agile than a heavy division. Such a force is considered by many, including General (retired) George Joulwan, former NATO commander, to be an answer to the Army's dilemma of being able to either rapidly deploy, or arrive with overpowering muscle, but not both.[28]

The DCX, by contrast, is designed to demonstrate the capabilities of the Army's first digitized heavy division in a realistic training environment.[29] Inherent in the experiment will be new operational and organizational concepts, as well as the presence of some asymmetric threats. The JCF is scheduled for September '00, with DCX following one year later. Both experiments are managed by the Army Training and Doctrine Command (TRADOC) and are to be executed by a dedicated experimentation force—the 4th Infantry Division.

USACOM Joint Experimentation

In early 1998, the Congress expressed concern with the uncoordinated direction of DoD innovation, and hence designated the Commander-in-Chief, USACOM (CINCUSACOM), as the Executive Agent for Joint Experimentation, effective 1 October 1998.[30] A specific branch of USACOM, the Joint Experimentation Directorate (J-9), has been activated to manage the effort. This milestone fully institutionalizes experimentation throughout DoD, leaving no doubt as to the support and faith of senior leadership in experimentation as an innovation tool. Of particular interest, at this early stage of development, is the appropriate role of J-9 in the overall experimentation process. Since USACOM has yet to conduct an actual experiment in the sense of the service events described above, the following observations are based on USACOM's planned, rather than active role.

Admiral H.W. Gehman, Jr., CINCUSACOM, has clearly stated his intent with respect to joint experimentation: "We must be able to experiment now with innovative concepts,

looking for evolutionary and revolutionary improvements in military capabilities in order to provide the warfighters and National Command Authority with a full range of options in facing future challenges."[31] Further emphasis is given to "synchronize service experiments, promoting results-sharing and reducing redundancy" and developing the "best 'value added' recommendations for changes in Doctrine, Organization, Training and Education, Materiel, Leadership, and Personnel (DOTMLP) needed for the success of our future joint forces."[32]

The J-9 organization is still in the process of standing up, but it is projected to include 200-300 government and civilian personnel.[33] At present, they act as "observers" at each of the service experiments. In late 2000, the first opportunity for a "joint experimentation event" arises. Rather than a being a true joint experiment, this event essentially consists of the concurrent execution of four service experiments. While J-9 will be involved in planning and coordination, the execution of the experiments will remain the responsibility of the services. At present, there are no scheduled formal joint experiments which fall under the direction of USACOM. The first is expected to occur in 2004.[34]

Based on the documented intent and initial involvement of USACOM, they appear to be postured to assume an appropriate role in the experimentation process. Nevertheless, there is some anxiety among the organizations responsible for service experimentation. It stems from the planned size of the J-9 organization and an anticipation that it could easily attempt to wield its power over the services, potentially hindering their development of core competencies and stifling beneficial competition between them.[35] The apprehension has, in fact, prompted the Army to draft a Memorandum of Agreement (MOA), clearly specifying service and USACOM roles in joint experimentation.[36]

Is Experimentation On Track?

Is experimentation fulfilling its promise? Is it likely to lead to both *evolutionary* and *revolutionary* improvements in warfighting capability for operational level commanders? Having reviewed the basic characteristics of the service programs, the analysis will now proceed to a comparison of each to the benchmark criteria. The results are summarized in Table I. The planned USACOM program *will not* be evaluated, as such an analysis is considered premature.

Table I
Comparison of Experimentation Programs With Benchmark Criteria

	Relevance	Responsiveness	Freedom to Fail	Flexibility	Buy-In Potential
Fleet Battle Experiments	✓	✓	✓		✓
Sea Dragon	✓			✓	✓
Expeditionary Force Experiments	✓	✓	✓		✓
Force XXI	✓			✓	

In most respects, Navy FBEs conform well to the benchmark criteria. The Navy has designed a relevant and responsive experimentation process, where failure is not only acceptable, but expected. As an example, these characteristics have paid large dividends in the iterative development of the "ring of fire" concept, which is a means of combining Navy and Army fires in a digital sensor-to-shooter network to counter the huge ordnance rate that could be massed in an enemy attack against Seoul, Korea—the Fleet Commander's number one problem.[36] Furthermore, the buy-in potential of the Navy's process is relatively high, especially if the ongoing attempts to connect the Naval War College and NWDC with Numbered Fleet activities succeeds as it did between World War I and II. With respect to

flexibility, however, the concepts demonstrated by FBEs so far have clearly been technology-focused, specifically in the realm of information superiority. By comparison, operational, organizational and doctrinal adaptations are receiving little attention. Even though the focus on technology at the high end of the conflict spectrum is by design, it is worth considering the contrast between the current FBE approach and that of carrier aviation experimentation discussed earlier. In the interwar years, new operational concepts were the source of innovation. One has to wonder whether the more restricted focus of today will mask similar revolutionary operational, organizational, or doctrinal concepts.

The Marine Corps Sea Dragon program stands alone in its degree of relevance and flexibility. Hunter Warrior, Urban Warrior, and Capable Warrior are the only experiments which are truly exploring the entire conflict spectrum in both a symmetric and asymmetric sense. Furthermore, both evolutionary and revolutionary approaches are being investigated with respect to new technologies, as well as operational, organizational, and doctrinal concepts. In addition, as in FBEs, buy-in potential is maximized by the continuing participation of operational elements in the SPMAGTF(X). However, by contrast, the reduced frequency between Sea Dragon AWEs (every two years) compared to Navy FBEs (every six months) may decrease the tolerance of failure and ability to adjust to failure.

The Air Force EFX program also appears to conform to most of the benchmark criteria in its early stages. With the annual recurrence and an iterative development process in place similar to Navy FBEs, many benefits are likely to be realized in the near and mid-term.[37] However, again similar to Navy experiments, EFXs also tend to rely heavily on information superiority-based technology solutions to improve command and control (C2). Furthermore, even though there are plans to evaluate some non-traditional threats in JEFX '99, the

dominant focus is on evolving the Aerospace Expeditionary Force (AEF) concept against more conventional threats. Obviously, the C2 emphasis is important, as it forms a key component of the future USAF vision of Global Engagement.[38] Nevertheless, the restricted focus may again mask potential operational, organizational, or doctrinal solutions, specifically against asymmetric threats or attacks at the low end of the conflict spectrum. Moreover, such a focus offers little hope of revealing alternatives if the AEF concept turns out to be faulty.

Finally, the Army Force XXI experiments offer the strong points of relevance and flexibility, though not quite to the degree of Sea Dragon. A legitimate attempt is being made to explore technological, operational, organizational, and doctrinal changes against the full conflict spectrum. However, the sheer size of the efforts in terms of personnel and dollars makes one question the freedom to fail, since frequent experiments of this magnitude will likely be cost prohibitive.[39] Moreover, as the only user of a dedicated experimentation force, the Army may find that operators become "experts" in the experimentation process, thus skewing results. Finally, a dedicated force may also hinder buy-in. In fact, such a struggle is already evident. The Army Chief of Staff, General Dennis Reimer, recently canceled plans to remold an existing unit into the first operational strike force, considering it "expensive and risky."[40] This highlights how difficult buy-in of revolutionary concepts continues to be even today, just as was the case with armored warfare during the interwar years.

Is Technology the Answer?

When held up against the benchmark criteria, service experimentation programs appear in many ways to complement the innovation process. However, with few exceptions, there is a dominant focus on technology-centered concepts, as well as a tendency to explore primarily the high end of the conflict spectrum. Given the heavy technology focus contained

in such documents as Joint Vision 2010, as well as the service visions for the 21st century, critics might debate that experiments are indeed covering the appropriate parts of the conflict spectrum, with the appropriate technology emphasis. Arguably, therefore, confidence should run high in regards to experimentation. Or should it?

Since the transition to the "information age" began after the Vietnam War, our forces have been predominantly engaged in the lower end of the conflict spectrum. This is also where we have had the greatest difficulty with success. One need not look much beyond Vietnam, Somalia, or now, Serbia/Kosovo, to recognize that an overwhelming technology edge does not always guarantee victory.

The present approach to experimentation may indeed increase the capability of the U.S. military against any potential peer or conventional threat. Maintaining such an advantage is certainly important, but the U.S. advantage over such competitors is already extremely large, making this neither a balanced nor optimum approach. In fact, it runs the risk of driving "weaker" competitors to seek asymmetric means to threaten our forces. For example, they might simply deny our forces navigation or targeting information.

Keeping in mind current DoD guidance to achieve "full spectrum dominance," and current doctrinal guidance, which clearly points towards preparing for symmetric and asymmetric threats throughout the conflict spectrum, a reconsideration of the focus of experimentation is in order.[41] While it is acknowledged that other innovation tools are available, such as Joint Test & Evaluation (JT&E) or joint exercises, experimentation alone provides the unique freedom to combine innovative concepts with operational scenarios while providing maximum visibility throughout the warfighting community.

The Way Forward—Increasing the Relevance of Experimentation

In general, DoD efforts to improve the innovation process through experimentation should be applauded. Nonetheless, as should be expected with any process in its early stages, there is room for improvement. How, then, can the experimentation process be optimized to allow both evolutionary and revolutionary innovation to occur throughout the conflict spectrum? Based on the preceding analysis, the following general recommendations are presented for interservice and USACOM consideration as their respective programs evolve.

Service Experimentation

Expand Scope. In addition to technology solutions, a conscious effort should be made to increase experimentation with potential operational, organizational, and doctrinal concepts. One possible scenario might explore how existing technologies and forces could be most effectively arrayed against a near-peer competitor who has ceded conventional air superiority to the U.S. military. Such a competitor may have instead developed a large arsenal of ballistic missiles which they could launch in high-density salvos against key targets, such as airbases—the idea being to destroy our fighters *before* they launch.

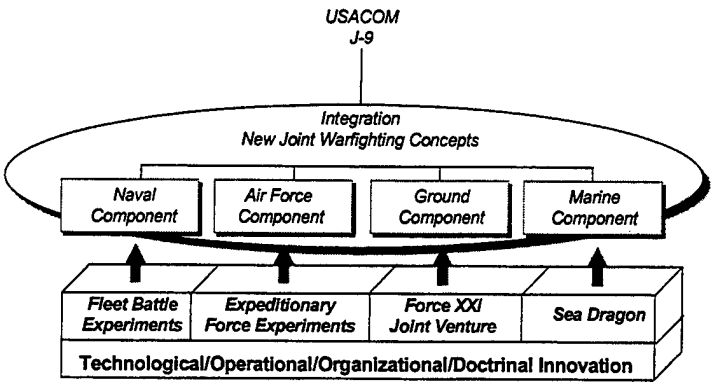
Increase Responsiveness. Currently, service experiments are occurring at rigid periodic intervals, in most cases not often enough to benefit a CINC during his watch. Furthermore, CINC staffs should be able to influence the content and scheduling of an experiment to specifically support a warfighting challenge in their theater. The best model is currently provided by Navy Fleet Battle Experiments, which are tied directly to Numbered Fleet exercises and occur at six month intervals, thus allowing them to be the most responsive, flexible, and tolerant of failure.

Increase Visibility. Operators at all three levels of war (tactical, operational, and strategic) must have greater visibility to the service and joint experimentation efforts in order to increase the potential for buy-in, as well as the source of ideas. Potential innovators are spread throughout the warfighting community. Their ideas must merely be brought into the experimentation arena. Further, programs should truly encourage and reward revolutionary thinking throughout the conflict spectrum, remembering that the freedom to fail is crucial. If done correctly, the eyes of senior leaders and operational commanders may be opened in a manner that causes them to overcome traditional resistance to revolutionary innovation. In other words, they may realize "there is a substantial cost for failure to recognize revolutionary changes in warfare."[43]

USACOM Role in Experimentation

Involvement Without Interference. With respect to service innovation and experimentation efforts, USACOM should be highly involved, yet not intrusive in a manner that hinders service development of core competencies. In other words, the relationship between service experimentation and USACOM joint experimentation should be analogous to the relationships within a JTF. For example, when a joint experiment is appropriate to explore, demonstrate, or verify new joint warfighting concepts, USACOM J-9 could stand up an "Experimentation JTF," with J-9 as the JFC (Figure 2).[44] Each of the services would then provide forces to USACOM, over which they act as component commanders. In this sense, the services would remain responsible for innovation with respect to core competencies, while J-9 would be responsible for the optimum *integration* of service innovations, whether technological, operational, organizational, or doctrinal.[45]

Figure 2
Notional Experimentation Joint Task Force



Honest Broker. All service experimentation should involve USACOM in a coordinating role. As an honest broker, USACOM should insure the relevant concerns of operational commanders are being addressed and that service efforts are leveraging off each other while not being redundant. Further, they should insure that competition between the services is constructive, not destructive, and that the best technologies and concepts are brought forward into the joint warfighting arena at the appropriate time, and are interoperable. As an example, some of the most successful concepts of the Marine Corps' Hunter Warrior AWE have not been aggressively pursued. Specifically, the sensor-to-shooter concepts were seen by some as inappropriately technology-focused and largely incompatible with traditional Marine Corps doctrine emphasizing maneuver warfare.[46] An honest broker with familiarity across the services could have brought these concepts forward, either to another service or into the joint warfighting arena.

Conclusion

A review of the present direction of service and joint experimentation reveals many positive qualities. However, there are some areas where the tendency is towards providing

primarily technology-centered concepts to increase an already extremely wide gap between the U.S. military and any potential peer, conventional, or symmetric threat. This is not an optimum use of resources. An increase in experimentation at the lower end of the conflict spectrum, as well as greater openness to both *evolutionary* and *revolutionary* operational, organizational, and doctrinal concepts throughout the spectrum, would provide a more appropriate balance for operational commanders they enter the 21st century. Furthermore, USACOM's new role as the Chairman's joint experimentation representative hangs in the balance with respect to an ability to either hinder or greatly facilitate the overall DoD innovation process. Care must be taken to insure that USACOM's role becomes that of an *integrator* of service innovation rather than the driving force behind it.

Now is the time to refine and optimize the process of experimentation. The potential payoff to future operational level commanders is immense. In fact, when the continually increasing rate of technology change is combined with institutionalized experimentation throughout DoD, there is an unprecedented opportunity to institutionalize innovation itself, perhaps like never before in U.S. military history.

NOTES

[1] Steven Komarow, "Viable Ground-Troop Option Would Take Months," USA Today, 19 April 1999, A:3. The Army plans to experiment with a "strike force" in late 1999, the details of which will be described later in this analysis.

[2] For the purposes of this research, the term "operational level commander" is considered to include Commanders-in-Chief (CINCs), Joint Forces Commanders (JFCs), and Joint Task Force (JTF) Commanders. These terms will be used interchangeably throughout the analysis.

[3] While experimentation has significant applications in the near, mid, and far-term, this research effort focuses solely on the near and mid-term, i.e. the strategic horizon of present operational commanders and their replacements (approximately five years out).

[4] U.S. Atlantic Command, Joint Experimentation Implementation Plan (Norfolk, VA, July 1998), vi; U.S. Joint Chiefs of Staff, Joint Vision 2010 (Washington, D.C.), 1, 8. Among other things, the USACOM Implementation Plan explains the relationship of USACOM Joint Experimentation to the Joint Vision 2010 (JV 2010) implementation process. Joint Vision 2010 expresses how technological innovation and information superiority will enable four new operational concepts: Dominant Maneuver, Precision Engagement, Full Dimensional Protection, and Focused Logistics. Together, these operational concepts define the desired end state of Full Spectrum Dominance. The intent of this research is not to argue the validity of the strategic or operational vision provided by JV 2010. At issue, rather, is how well service and joint experimentation efforts are improving the *innovation* process, which is considered significant regardless of the validity of JV 2010.

[5] It is important to emphasize that, throughout this analysis, the term "innovation" includes not only new technology, but also any new operational, organizational, or doctrinal concepts that might potentially improve warfighting capability. It is also important to distinguish between evolutionary and revolutionary innovation. An example of *evolutionary* innovation would be equipping the heavy armored division in the introductory scenario with new, increased-firepower tanks. Totally restructuring the basic fighting unit, with or without new technology, would be considered *revolutionary*.

[6] Bernard J. Smith, "Navy Warfare Development Command Introductory Brief," Lecture, U.S. Naval War College, Newport, RI: 23 March 1999.

[7] In academia (e.g. science experiments, laboratory tests), experiments are typically conducted in controlled environments and produce repeatable results.

[8] U.S. Joint Chiefs of Staff, Joint Vision Implementation Master Plan, CJCSI 3010.02 (Washington, D.C.: 9 December 1998), 10-11. Several other assessment tools are also available, including wargames, Advanced Technology Demonstrations (ATDs), Advanced Concept Technology Demonstrations (ACTDs), and Joint Test & Evaluation. Those chosen here were considered the most appropriate to illustrate the proper role of experimentation.

[9] Timothy K. Nenninger, "The Experimental Mechanized Forces," Armor, May-June 1969, 33-37.

[10] Harold R. Winton, To Change an Army (Lawrence: University Press of Kansas, 1988), 202-203.

[11] Williamson Murray, "Innovation: Past and Future," Joint Forces Quarterly, Summer 1996, 55.

[12] F.G. Hoffman, "Innovation Can Be Messy," U.S. Naval Institute Proceedings, January 1998, 47; Williamson Murray, "Thinking About Revolutions in Military Affairs," Joint Forces Quarterly, Summer 1997, 70. Interestingly enough, of the four elements that are widely considered essential to a Revolution in Military

Affairs (RMA), history suggests that technology has played only a minor role in most previous RMAs while operational, organizational, and doctrinal changes have proven more crucial. We cannot predict with any accuracy whether or not we are in an RMA, and it is not the intent of this research effort to do so. Suffice it to say that successful experimentation can optimize our chances of capitalizing on an RMA, if indeed we are in one.

[13] Williamson Murray and Allan R. Millett, Military Innovation in the Interwar Period (United Kingdom: Cambridge University Press, 1996), 317, 347.

[14] These criteria have been chosen specifically for the near and mid-term focus of operational commanders, as mentioned earlier. Therefore, they may not necessarily apply to the far term (beyond five-years). For example, it is certainly worthwhile to explore concepts through experiments in the far term that may not be "relevant" to the operational commander of today. Furthermore, the list is neither meant to be exhaustive nor used as a checklist to insure success. Its purpose is simply to provide a common basis of useful measures for examining whether present experimentation efforts are best meeting the needs of operational level commanders.

[15] While it is acknowledged this is a somewhat vague criterion, the question must nevertheless be asked. The JV 2010 Desired Operational Capabilities (DOCs) are a good place to start for operational relevance. However, the complexity of the technological, operational, organizational, or doctrinal change under investigation must also be considered. The focus should be on maximizing the potential for rapid fielding. For example, an off-the-shelf system is probably more relevant for experimentation in the near and mid-term than a complex new technology not yet adequately developed.

[16] Also important to buy-in potential are the processes for rapidly transitioning successful efforts into changes in Doctrine, Organization, Training and Education, Materiel, Leadership, and Personnel (DOTMLP). Obviously, such change processes differ between the services. The effectiveness of these processes, while certainly significant, is the subject of another study. The focus here is solely on designing experiments which explore the limits of technological, operational, organizational, and doctrinal innovation with respect to CINC needs, for without success at this point, the DOTMLP changes are meaningless. While buy-in is simplified for evolutionary improvements, it is traditionally much more difficult for revolutionary concepts, hence the need to closely connect the experimentation process with the warfighters.

[17] The finer details of service and joint experimentation programs could each form the basis of separate research efforts. The purpose here is to examine only the top-level elements necessary for adequate comparison with the benchmark criteria, and between the programs themselves.

[18] "Navy Warfare Development Command Introductory Brief."

[19] U.S. Naval War College, Fleet Battle Experiment Bravo Quicklook Report (Newport, RI: 22 September 1997), Enclosure 1.

[20] Wayne Perras, Operations Department Chief, Navy Warfare Development Command, interview by author, 22 April 1999, Sims Hall, Newport, RI. The NWDC has made a conscious decision to experiment at the high end of the conflict spectrum since this is considered appropriate for the Navy's present doctrinal focus.

[21] Arthur K. Cebrowski and John J. Garstka, "Network-Centric Warfare—Its Origin and Future," U.S. Naval Institute Proceedings, January 1988, 30, 32. Network-centric warfare uses information technologies to dramatically increase the speed of command in warfighting through integration of large numbers of sensors and computational nodes.

[22] "Marine Corps Warfighting Lab Home Page," <http://208.198.29.7/mcwl-hot/home/index.html> (30 March 1999).

[23] Bradford M. Sargant, "The Hunter Warrior Awe: Maiden Voyage of the Dragon," Marine Corps Gazette, June 1997, 15-17; John F. Schmitt, "A Critique of the Hunter Warrior Concept," Marine Corps Gazette, June 1998, 13-14. The smaller force consisted of dispersed rifle squads whose function was to spot and direct naval surface fire and tactical air support against the larger force in a sensor-to-shooter fashion. In effect, it was an asymmetric engagement in which the enemy force was not engaged in actual combat, but rather defeated by long-range, precision fires from standoff ranges.

[24] "Marine Corps Warfighting Lab Home Page."

[25] "Expeditionary Force Experiment Executive Summary," <http://efxlink.acc.af.mil/final98/ex_sum.html> (30 March 1999).

[26] Ibid.

[27] "Joint Contingency Force Advanced Warfighting Experiment: Operational Concepts Patterns, Competencies, Components, Pillars," <http://150.184.68.24/JointVenture/JCFAWE/JCF1_2.ppt> (30 March 1999).

[28] Komarow, A:3.

[29] "Division Capstone Exercise," <http: 150.184.68.24/JointVenture/dcx/dcxv15.ppt> (30 March 1999).

[30] U.S. Atlantic Command, Joint Experimentation Campaign Plan '99 (Norfolk, VA, November 1998), 1-8.

[31] Ibid, iv.

[32] Ibid, v.

[33] Joint Experimentation Implementation Plan, xii.

[34] Aaron Johnson, Chief, Joint Experimentation Operations Division, telephone conversation with author, 27 April 1999.

[35] Interview, Perras.

[36] U.S. Atlantic Command, USACOM Experiment Event J0002 Draft Memorandum of Agreement, (Norfolk, VA, anticipated period of performance of 15 June 1999 through 31 May 2001), 2. As an example, the draft MOA states: "Service-specific experimentation and training remain a service responsibility, with USACOM focused on the designated joint objectives of experimentation."

[37] "Navy Warfare Development Command Introductory Brief"; U.S. Naval War College, Fleet Battle Experiment Delta Quicklook Report (Newport, RI: 2 November 1998), 3, 2-3. The purpose here is not to argue the validity of the "ring of fire" or any other concept presently being investigated through experimentation. However, one benefit of the iterative development approach is worthy of mention—that of "leave-behind" capabilities. For example, the "ring of fire" development process has resulted in twenty-two Land Attack Warfare System stations remaining in theater, thus providing a limited means of displaying more timely target engagement data.

[38] Robert Wall, "Expeditionary Nerve Center," Air Force Magazine, August 1998, 65-66. The iterative process being employed by EFX is called "spiral development." It has also resulted in leave-behind systems.

[39] Department of the Air Force, Global Engagement: A Vision For The 21st Century Air Force (Washington, D.C.), 13.

[40] Telephone conversation, Johnson.

[41] Komarow, A:3.

[42] Joint Warfighting Center, Concept for Future Joint Operations—Expanding Joint Vision 2010 (Fort Monroe, VA, May 1997), ii; U.S. Joint Chiefs of Staff, Joint Warfare of the Armed Forces of the United States (Joint Pub 1) (Washington, D.C.: 10 January 1995), IV-10-12.

[43] James R. Fitzsimonds and Jan M. Van Tol, "Revolutions in Military Affairs," Joint Forces Quarterly, Spring 1994, 28, 30. Methods of increasing the visibility to the DoD experimentation process, as well as warfighter participation in the process, are the worthy subjects of further study.

[44] Interview, Perras. The author is grateful to Mr. Wayne Perras for his comments which formed a bases for the notional concept of an Experimentation JTF.

[45] Hoffman, 50. As to whether the services can be trusted to innovate on their own in a manner that will benefit the joint warfighting community, an observation by Lieutenant General Bernard E. Trainor, U.S. Marine Corps (Retired), is insightful: "If for its sake conformity is achieved at the expense of uniqueness, we could end up with a military that is inflexible, uncreative, and most importantly, predictable.

[46] Schmitt, 13.

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